On-Site Sewage Systems

Definition: An integrated arrangement of components for a residence, building, industrial establishment or other places not connected to a public sewer which convey, store, treat, and/or provide subsurface soil treatment and disposal on the property where it originates, upon adjacent or nearby property; and includes piping, treatment devices, other accessories, and soil underlying the disposal component of the initial and reserve areas. (WAC 246-272-01001)

Summary

Proper disposal of human sewage is a basic function of public environmental health practices. Sewage carries pathogens (bacteria and viruses) and may contain chemicals that are known to cause disease in man or harm the environment. The route of human exposure is through food, such as shellfish, or through drinking water.

In 1994, municipal sewage systems served about 58% of the population of Washington. The other 42% were served by a variety of on-site systems, large and small, which, due to a lack of professional operators and management, may carry a higher risk of human exposure to sewage-related contaminants. Properly designed, sited, installed, operated, and maintained on-site sewage systems can reduce this risk of exposure.

Time Trends

Large epidemics caused by sewage-contaminated food and water have vanished in the United States due to the application of public health knowledge and sanitary science to sewage treatment and disposal. However, the agents involved (cholera and typhoid, for example) are still present and could re-emerge without adequate safeguards.[1]

One trend has been an increase in the attention to sewage treatment technology. Recent developments include numerous design options for difficult building sites and an increase in the use of pre-treatment devices and technology.

Another trend has been a decrease in municipal sewer construction and expansion, placing a greater burden on on-site technology and practices. Highly concentrated housing development often creates a need for large, multi-user on-site systems.

About 42% of Washington's population are served by on-site sewage systems. On-site systems with flows in excess of 14,500 gallons per day and municipal treatment plants are under the jurisdiction of the Department of Ecology and not addressed in this report. Large on-site systems with capacity between 3500 gallons per day and 14,500 gallons per day are under the jurisdiction of the Department of Health. These system serve an estimated 3% of the population.

The rest of the population is served by small, individual, on-site systems with flows less than 3500 gallons per day under local health jurisdiction.

Adequate design and installation are important, but long-term performance of on-site systems requires ongoing operation and maintenance. An indicator of progress on this point is the number of large on-site systems operating under a permit, which provides a mechanism to ensure that some level of maintenance is in place. A second indicator is the increase in activity to certify those providing maintenance.[2]

Year 2000 Goals

One goal is to increase the percentage of large on-site wastewater systems which comply with operating permit requirements to 95%. Compliance with operating permit requirements would mean that the system has a designated, responsible owner, construction records are on file, and an operations and maintenance manual has been approved and on file.

Geographic Distribution

On-site sewage systems are distributed throughout the state in rural, suburban, and even urban settings. A 1984 study of community systems noted 415 in 10 counties. Many of these were very large lagoon systems. The best estimate for Washington is 322 large on-site sewage systems in operation, of which 170 are under the Department of Health jurisdiction and subject to operational permits. They are distributed roughly evenly on either side of the Cascades (53% on the east side, 47% on the west).

Measures of Impact and Burden

Incidence of Failure. Numerous studies of the degree of on-site system failure have been conducted. Failure rates range from 2% in some locations to as high as 46%. The rate of failure is affected by the quality of the installation, the age of the system, the degree of maintenance, the geological siting (soils, slope), and the system's operation within design parameters. The degree of failure is also subject to the level of sophistication and precision used in failure analysis, ranging from visual observations to more complex and expensive bacterial testing, and dye tracing methodology. A 1992 study of 161 large on-site sewage system revealed 36 failures over a five year period, or 4.5% per year on average.

Operating Permits. Of the estimated 170 operating large on-site sewage systems under Department of Health jurisdiction, 120 have a permit and 36 more are under review for permit issuance. The remainder have not received an operating permit for a variety of reasons, including:

1) Lack of information, especially for older systems.

2) The system is under local jurisdiction through an agreement with the state, and the local jurisdiction has not instituted an operational permit program.

3) The state has not worked its way down the list to the particular system yet.

4) The system may have been evaluated and found in violation of performance standards and the operating permit is being withheld pending corrections.

Eutrofication. While the primary reason for regulating on-site sewage treatment systems is to keep potentially harmful bacteria and viruses out of food and water, there are other problems caused by improperly functioning on-site sewage systems. They can produce nitrogen and phosphorus which, when discharged into lakes or streams, act as fertilizer, increasing algae and vegetative growth, which removes oxygen from the water and potentially suffocates aquatic animals.

Nitrates. One by-product of a septic system is the water soluble nitrates (NO^3) that can be harmful to human health. This is an increasing concern with groundwater contamination and protection. Although the literature clearly associates elevated groundwater nitrates with agricultural practices, there is a need to better define the contribution of on-site sewage systems to this problem.

Shellfish. Because they filter and retain biomass from the water in which they grow, shellfish can retain pathogens from human sewage. Between 1991 and 1994, 7,390 acres of Washington shellfish growing area were downgraded primarily because of sewage from failing or poorly functioning on-site sewage treatment systems. About 2,570 acres have been upgraded after on-site system corrections were made

Because shellfish are sometimes eaten raw or prepared improperly, the risk of disease transmission from sewage contaminated shellfish is very real. In 1994, there was an outbreak of 48 cases of viral gastroenteritis linked to oysters contaminated with domestic sewage from failing on-site systems.

Risk and Protective Factors

There are three broad factors that can increase the risk of on-site sewage system failure and thus increase the risk of disease transmission or environmental damage:

Soils and Siting. Before construction, a site must be evaluated for its suitability to support a system. Such an evaluation includes description and analysis of soil type, soil textural classification, vertical separation to a restrictive layer or water table, horizontal setbacks to wells or surface water, depth to groundwater, and in some cases a determination of net density. Errors in any of these areas of analysis can lead to faulty design criteria which can promote failure of a system.

Quality of design and construction. If the site has been accurately analyzed, correct application of design criteria is the next essential. The type of system and its orientation on the property must be determined to ensure adequate treatment and disposal. Once an appropriate design has been produced, there must be proper construction that follows the design, using proper materials, with quality control inspections. Upon completion, correct specifications for future reference are necessary. Any deviation or error can render the system subject to problems.

Operation and maintenance. The final step is to properly operate and maintain the system. This includes periodic inspections and service, as needed. A major dilemma is convincing owners of the need to expend funds in preventive maintenance on something they typically can neither see nor hear. Many failures are due to owner neglect.

High Risk Groups

People. Anyone with reduced immunity to disease organisms, including enteric bacteria, is at a higher risk of infection if exposed.

Shellfish consumers, particularly recreational harvesters, are subject to a higher risk if sewage is discharged near or at the harvest site.

Systems. Older systems (pre-1975) that were designed and installed prior to state design standards may be more prone to problems. Much depends on the level of maintenance provided and the quality of design and installation. Some studies suggest that the risk of failure also increases with the volume of sewage treated by the system.[3]

Intervention Points, Strategies and Effectiveness

There are a number of on-going and developing programs to assist in the long term, successful operation of on-site systems:

Education. The current state of on-site sewage system technology is sophisticated and highly technical. Many who should have an understanding of this technology do not. This includes the general public, homeowners, many engineers and designers, a number of regulators, and some policy makers.

While there have been significant advances in understanding the mechanics of soil treatment and design technology, many still view on-site systems as temporary in nature and have an “out of sight, out of mind” mentality. Current efforts across the state are aimed at increasing the knowledge of all the affected parties when dealing with on-site sewage systems.

Certified Professionals. There is a need for special levels of expertise within the industry. This includes the engineer, the sanitarian, the designer, the installer, and the pumper. Interest in certified operation and maintenance professionals is growing. The more these professionals know, the better homeowners can be educated and the better systems will be designed, installed, and maintained.

Operation and Maintenance. The most significant need in the state is for an infrastructure to provide operation and maintenance of on-site systems. This was historically performed by homeowner groups or a single, private party. The effort now is to create larger, more comprehensive maintenance districts, or align with existing utility districts to provide these services.

Repair funds. For many owners of failed systems, the largest barrier to a successful repair is the cost. A number of counties are providing low-interest or no-interest loans to individuals and businesses to help offset the economic hardships of an expensive repair.

New Technologies. Despite the availability of many proven design approaches, there are still sites, both developed and undeveloped, that cannot be adequately serviced with existing technology. There is a need for continuous assessment and improvement in the application of existing technology. In addition, wastewater reuse, water conservation, and innovative treatment systems such as constructed wetlands are examples of emerging technologies that will offer more options for resolution of difficult site problems.

Inventory. Many large on-site sewage systems were constructed before the enactment of design standards or permit requirements. Many have been abandoned, and jurisdictional authority has shifted over time. Consequently, there is no accurate inventory of existing large on-site systems. Such an inventory must be compiled before problems and progress can be accurately assessed.

Data Sources

Public Health Improvement Plan, 1994.

Management Information System, Washington State Department of Health, Environmental Health Programs, 1994.

For More Information

Office of Community Environmental Health, Washington State Department of Health.

1994 Puget Sound Water Quality Management Plan.

Endnotes:

[1] MMWR, Jan 8, 1995, Vol. 43, Nos. 51 & 52, Table II, Cases of Selected Notifiable Diseases, U.S., weeks ending Dec.31, 1994 and Jan. 1, 1994.

[2] NW Washington On-Site Training Center, Puyallup, WA.

[3] Plews, Gary, Performance Evaluation of 369 Larger On-Site Systems: Proceeding of the 4th National Symposium of Individual and Small Community Sewage Systems, American Society of Agricultural Engineers, Dec. 10-11, 1984. (p. 372).